

***Nosopsyllus fasciatus* Parasitizing House Mice on
Southeast Farallon Island, California
(Siphonaptera: Ceratophyllidae)**

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Southeast Farallon Island is a small granitic island located near the edge of the continental shelf approximately 48 km WSW from the Golden Gate Bridge, San Francisco, California. Presently the island is under the jurisdiction of the San Francisco Bay National Wildlife Refuge and the 12th U.S. Coast Guard District. The Point Reyes Bird Observatory (PRBO) maintains a research station at the island with logistic support provided by the Coast Guard and the Oceanic Society. The island serves as an important sanctuary and breeding ground for 12 species of marine birds and 5 species of pinnipeds (Ainley and Lewis, 1974). Besides humans the only other land mammals presently residing on the island are house mice, *Mus musculus* Linnaeus (DeSante and Ainley, 1980). European rabbits, *Oryctolagus cuniculus* Lilljebord, exterminated from the island in 1974, had been resident beginning sometime between 1855-1876 (Pinney, 1965). Various domestic mammals including dogs, cats and mules have resided there during the past but are no longer present (DeSante and Ainley, 1980) and hoary bats, *Lasiurus cinereus* (Palisot de Beauvois), and red bats, *L. borealis* (Müller), occur in small numbers for brief periods during their fall migration (Tenaza, 1966; PRBO, unpubl.). The absence of rats, *Rattus norvegicus* (Berkenhout) and *R. rattus* (Linnaeus), (DeSante and Ainley, 1980) is an interesting aspect of the island's ecology considering the rather intense and continuous human activity since 1849 (Dougherty, 1971; Shanks and Shanks, 1978).

During 23 August to 6 September 1980 I visited the island to continue studies on the marine bird flea, *Ceratophyllus pelecani* Auguston, parasitizing western gulls, *Larus occidentalis* Audubon. During this period the house mouse population was at its annual peak (R. Boekelheide, pers. comm.) and the PRBO staff biologists were snap-trapping mice inside their house in an attempt to control the rather high indoor mouse infestation. House mice were present on both the main island and West End, a smaller island to the west separated by the narrow Jordan Channel, and mice were quite active on the southern marine terrace where large numbers of western gulls had recently nested. Because of the high mouse population, the dispersed gull population (gulls were no longer territorial about their nests and most hatching year gulls were capable of flight), and mouse activity in the gull nesting area, it appeared possible that the mice were serving as fall alternative hosts for the bird fleas. There is one record of *C. pelecani* collected from *Peromyscus maniculatus elusus* Nelson and Goldman, Santa Barbara Island, Channel Islands, California (Hubbard, 1947) and this flea will readily engorge on white mice in the laboratory (Schwan, unpubl.). Therefore, during my stay on the

island I examined house mice snap-trapped in the PRBO house and the nearby Coast Guard (CG) house, as well as a few I captured by hand outdoors. The results of these examinations are presented herein.

RESULTS

During 26 August–6 September 1980 I examined 48 house mice for fleas; 20 mice from the PRBO house, 18 from the CG house, and 10 from outdoors. While adult *C. pelecani* were still active in abandoned gull nests located near these houses, I found none on these mice. However, *C. pelecani* is a nest flea, spending little time on its avian host and one might not find many on mice either even though these fleas might be feeding on them. However, 26 of the 48 mice (54.2%) were infested with the northern rat flea, *Nosopsyllus fasciatus* (Bosc), a flea not previously known to occur on the island. I collected 39 *N. fasciatus* (27 males, 12 females) from the mice: flea index for all mice = 0.81, flea index for only infested mice = 1.50. One male and one female were also found in a mouse nest located under a board on the marine terrace.

The percentages of mice infested from the CG house, PRBO house and outdoors were 72.2%, 60.0% and 10.0%, respectively, while the *N. fasciatus* indices were, in the same order, 1.33, 0.70 and 0.10 fleas per mouse. These data suggest that *N. fasciatus* is more abundant on indoor mice compared to outdoor mice, although Eskey (1938) found the opposite for *N. fasciatus* infesting rats in San Francisco. The CG house, which has only occasional and short term human occupancy and no mouse control, contained mice which were more frequently infested and had a *N. fasciatus* index nearly double that found on the mice from the PRBO house. The PRBO house has continued human occupancy and mouse control and I suggest that the lower infestation rate and flea indices for PRBO house mice are probably due to a continual influx of relatively clean mice from outside.

Male mice outnumbered females 33 to 15. Forty-three of the 48 mice, weighed to the nearest 0.1 g, had a mean weight of 15.1 g (range 8.1–21.1 g) and 33 of these 43 mice (76.7%) weighed over 14 g and were therefore adult (DeLong, 1967). The mice were in good condition: they had clean pelage and no scars, most were molting and many had large fat deposits associated with their reproductive tracts, and none were infested with any mites, lice or ticks.

DISCUSSION

Prior to this study *N. fasciatus* was unknown on SE Farallon Island and the presence of an established *N. fasciatus* population on house mice in the absence of *Rattus* is interesting. For example, during November 1970 to December 1972 I trapped 253 house mice from a feral population in an annual grassland community near Hayward, Alameda Co., California (Schwan, unpubl.). No *Rattus* were present and from the house mice I collected 85 *Leptopsylla segnis* (Schönherr) (32 males and 53 females), 9 *Malaraeus telchinus* (Rothschild), (1 male and 8 females) and 1 male *Hystrichopsylla occidentalis* Holland. No *N. fasciatus* were found. The *M. telchinus* and *H. occidentalis* were primarily associated with sympatric voles, *Microtus californicus* (Peale) (Schwan, 1975). Linsdale and Davis (1956) examined 77 house mice in an area free of rats in Monterey Co., California and found no *N. fasciatus*. Other studies in the San Francisco Bay area have shown occasional light infestations of *N. fasciatus* on house mice in areas where mice

and rats occur together. Miles et al. (1957) reported 9 *N. fasciatus* from 227 house mice and Stark and Miles (1962) found an unreported low number on 27 mice. In Hawaii, Haas et al. (1972) commonly found *N. fasciatus* on house mice living with *R. rattus* and *R. exulans* (Peale) in a *Eucalyptus* plantation.

N. fasciatus is a rat flea endemic to Europe and the British Isles and has a world-wide distribution due to its association with commensal rodents (Buxton, 1941; Jordan, 1948; Lewis, 1975) and it is an important plague vector among rats (Pollitzer, 1954). The species is well established throughout the United States (Benton, 1980; Prince, 1943) and was first reported from San Francisco by Fox (1908) where it occurs on *R. norvegicus* during all months of the year (Eads and Barnes, 1976). It is found throughout much of California (Prince, 1943) and has recently been collected on San Miguel Island, Channel Islands, off the southern California coast (2 females ex: *Peromyscus maniculatus streator* Nelson and Goldman, collected 25 May 1978; B. C. Nelson, pers. comm.), an island also inhabited by roof rats. *N. fasciatus* occurs on the Hawaiian Islands (Haas et al., 1972) and has been recorded from Macquarie Island in the Subantarctic (Dunnet, 1961). Yet the species is not known to occur on *R. rattus* or *M. musculus* on the Galapagos Islands (Smit, 1970).

The time of introduction of both house mice and *N. fasciatus* to SE Farallon Island is not known. Pinney (1965) and Marshall and Nelson (1967) were the first to report house mice even occurring on the island, but mice probably reached the island many years before the 1960s. An early report of burrowing owls, *Athene cunicularia* (Bonaparte) nesting on the island (Dawson, 1911) and reported sightings of this owl back to 1887 (Bryant, 1888) may suggest the presence of mice before 1900. Burrowing owl pellets collected on the island during March 1980 contained skeletal remains of house mice (PRBO, unpubl. journal, 17 March 1980) but burrowing owls are known to include many prey items, including insects, in their diet (Bent, 1938). Therefore, past nesting of these owls does not necessarily prove the presence of mice at those times.

Regarding the introduction of *N. fasciatus*, this flea may have arrived on house mice, most likely from San Francisco, where Fox (1908) reported this flea primarily from rats but also small numbers from mice. Lewis (1967) stated that "*N. fasciatus* appears to be an unspecialized species of flea capable of colonizing new, unpopulated areas with relative ease" and "being an adaptable species, an expansion of the population in one locality may involve the transfer to a different, though related, host." However, house mice generally carry few fleas and Worth (1950), although experimenting with *Xenopsylla cheopis* (Rothschild), concluded that house mice would unlikely participate significantly to the dispersal of rat fleas. Another possible route of introduction, although remote, could have involved an infested avian predator, flying from the mainland, as discussed by Jellison (1939) regarding the role of predatory birds in the dispersal of fleas and plague. However, I believe the presence of *N. fasciatus* on the island indicates past unsuccessful introductions of *R. norvegicus* or *R. rattus*. As mentioned earlier, the absence of rats is interesting in spite of much human disturbance to the island, such disturbance even being reflected by the high percentage of exotic plant species (Coulter, 1971). One possible explanation is that rats were exterminated many years ago during the unsuccessful poisoning campaigns to control rabbits.

In conclusion, the flea *Nosopsyllus fasciatus* is established as a house mouse

flea on SE Farallon Island and its presence suggests previous unsuccessful introductions of rats to the island. *N. fasciatus* is the fourth species of flea now known to occur on the island, the others being *C. pelecani*, a nest flea primarily of gulls and cormorants, *Actenopsylla suavis* Jordan & Rothschild, a nest flea of Cassin's auklets, and *Dasypsyllus gallinulae perpinnatus* (Baker), a nest flea of passerine birds.

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